

# FMS6410

## Dual Channel Video Drivers with Integrated Filters and Composite Video Summer

### Video Features

- Dual integrated video low pass reconstruction filters on outputs
- Composite Video Summer
- Integrated output drivers provide low impedance outputs and deliver 2Vp-p (6dB gain) video into 150Ω.
- 7.1MHz 4<sup>th</sup> order video filters
- 7.1MHz Y and C filters, with CV out
- 42dB stopband attenuation at 27MHz on Y, C, and CV
- Better than 1dB flatness to 4.5 MHz on Y, C, and CV
- No external frequency select components or clocks
- 9ns group delay flatness on Y, C, and CV output
- AC coupled inputs and outputs
- 0.4% differential gain with 0.4° differential phase
- Integrated DC Restore / Clamp circuitry with low tilt

### Applications

- CCTV
- Cable and Satellite Set top boxes
- DVD players
- Televisions
- Personal Video Recorders (PVRs)
- Video On Demand (VOD)
- Distribution Amplifiers

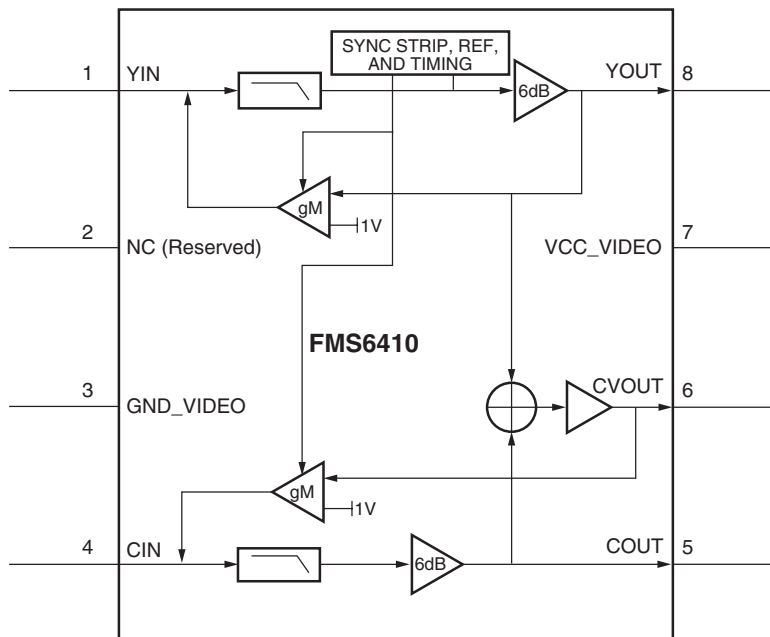
### General Description

The FMS6410 Dual Channel Video Filter – Driver Chip with CV Summer offers comprehensive video filtering for set top box or DVD applications. This part consists of two 4<sup>th</sup> order Butterworth 7.1MHz low pass filters for video signals. The filters are optimized for low overshoot and flat group delay. The device also contains a summing circuit to generate filtered composite video. Integrated video drivers are included to facilitate a direct drive to the outside world.

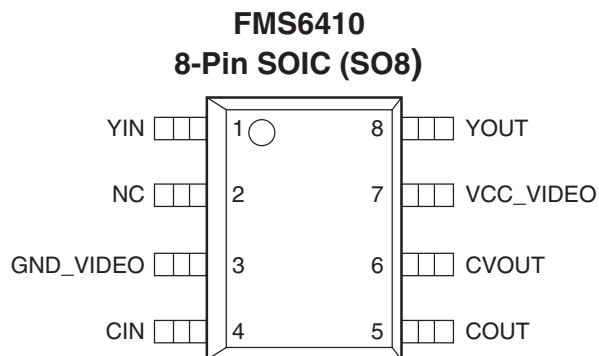
In a typical application, the Y and C input signals from DACs are AC coupled into the filter. Both channels have DC restore circuitry to clamp the DC input levels during video sync. The Y and C channels use a separate feedback clamp. The clamp pulse is derived from the Y channel.

The outputs are AC coupled. The Y, C and, CV outputs are buffered to drive 2Vp-p into a 150Ω load (1Vp-p into a doubly terminated 75Ω coax load) with up to 35pF of load capacitance at the output pin. The Y, C, and CV channels have a gain of approximately 2 (6dB) with 1Vp-p input levels. There is an option for the video output to be DC coupled which limits the drive output to one output on each channel.

### Functional Block Diagram



## Pin Configuration



| Video Section     |           |        |                                      |
|-------------------|-----------|--------|--------------------------------------|
| Pin#              | Pin       | Type   | Description                          |
| 1                 | YIN       | Input  | Luma (Luminance) / Composite Input   |
| 4                 | CIN       | Input  | Chroma (Chrominance) Input           |
| 5                 | COUT      | Output | Filtered Chroma (Chrominance) Output |
| 6                 | CVOUT     | Output | Summed Composite Video Output        |
| 8                 | YOUT      | Output | Filtered Luma (Luminance) Output     |
| Power/Ground Pins |           |        |                                      |
| 7                 | VCC_VIDEO | Power  | +5 VDC for Video                     |
| 3                 | GND_VIDEO | Power  | Ground for Video                     |
| 2                 | NC        | NC     | Reserved (Need to Float)             |

## Functional Description

### Introduction

The FMS6410 is a dual monolithic continuous time video filter designed for reconstructing the luminance and chrominance signals from an S-Video D/A source. The Composite video output is generated by summing the filtered Y and C outputs. The chip is intended for use in applications with AC coupled inputs and AC coupled outputs (See Figure 1). The reconstruction filters approximate a 4th-order Butterworth characteristic with an optimization toward low overshoot and flat group delay. Y, C, and CV outputs are capable of driving 2V<sub>p-p</sub> into AC coupled 150Ω video loads with up to 35pF of load capacitance at the output pin. All channels are clamped during sync to establish the appropriate output voltage swing range. Thus the input coupling capacitors do not behave according to the conventional RC time constant. Clamping for all channels settles to less than 10mv within 5ms of a change in video input sources. In most applications the input coupling capacitors are 0.1μF. The Y and C inputs typically sink 1μA during active video, which nominally tilts a horizontal line by about 2mV at the Y output. During sync, the clamp typically sources 20μA to restore the DC level. The net result is that the average input current is zero. Any change in the input coupling capacitor's value will inversely alter the amount of tilt per line. Such a change will also linearly affect the clamp response times. This product is robust and stable under all stated load and input conditions. Capacitive bypassing of VCC directly to ground ensures this performance.

### Luminance (Y) I/O

The luma input is driven by either a low impedance source of 1V<sub>p-p</sub> or the output of a 75Ω terminated line. The input is required to be AC coupled via a 0.1μF coupling capacitor which allows for a settling time of 5ms. The luma output is capable of driving an AC coupled 150Ω load at 2V<sub>p-p</sub>, or 1V<sub>p-p</sub> into a doubly terminated 75Ω load. Up to 35pF of load capacitance (at the output pin) can be driven without stability or slew issues. The output is AC coupled with a 220μF or larger AC coupling capacitor.

### Chrominance (C) I/O

The chroma input is driven by a low impedance source of 0.7V<sub>p-p</sub> or the output of a 75Ω terminated line. The input is required to be AC coupled via a 0.1μF coupling capacitor which allows for a clamp setting time of 5ms. The chroma output is capable of driving an AC coupled 150Ω load at 2V<sub>p-p</sub>, or 1V<sub>p-p</sub> into a doubly terminated 75Ω load. Up to 35pF of load capacitance can be driven without stability or slew issues. A 0.1μF AC coupling capacitor is recommended at the output. Since chrominance signals do not contain low frequency components, the smaller 0.1μF cap is recommended instead of the 220μF cap to reduce circuit cost.

### Composite Video (CV) Output

The composite video output is capable of driving 2 loads to 2V<sub>p-p</sub>. It is intended to drive a TV and a VCR. Either the TV input or the VCR input can be shorted to ground and the other output will still meet specifications. Up to 35pF of load capacitance (at the output pin) can be driven without stability or slew issues.

### DC Coupled Output Applications

The 220μF capacitor coupled with the 150Ω termination forms a high pass filter that blocks the DC while passing the video frequencies and avoiding tilt. Lower values such as 10μF would create a problem. By AC coupling, the average DC level is zero. Thus, the output voltages of all channels will be centered around zero. Alternately, DC coupling the output of the FMS6410 is allowable. There are several tradeoffs: The average DC level on the outputs will be 2V; Each output will dissipate an additional 40mW nominally; The application will need to accommodate a 1V DC offset sync tip; And it is recommended to limit each output to one 150Ω load.

# Typical Applications

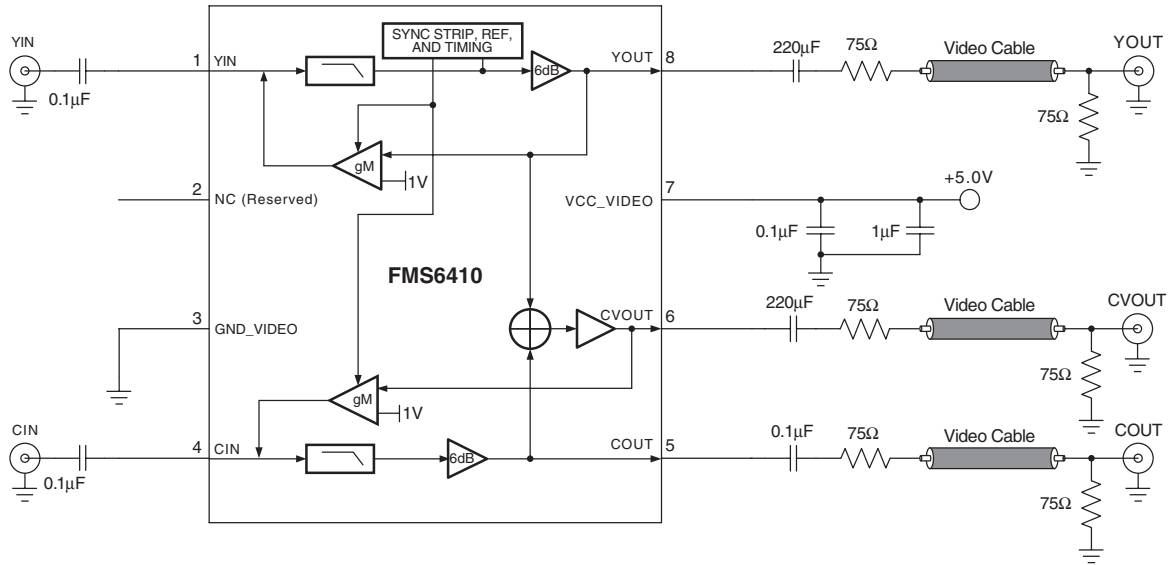


Figure 1. Typical Configuration

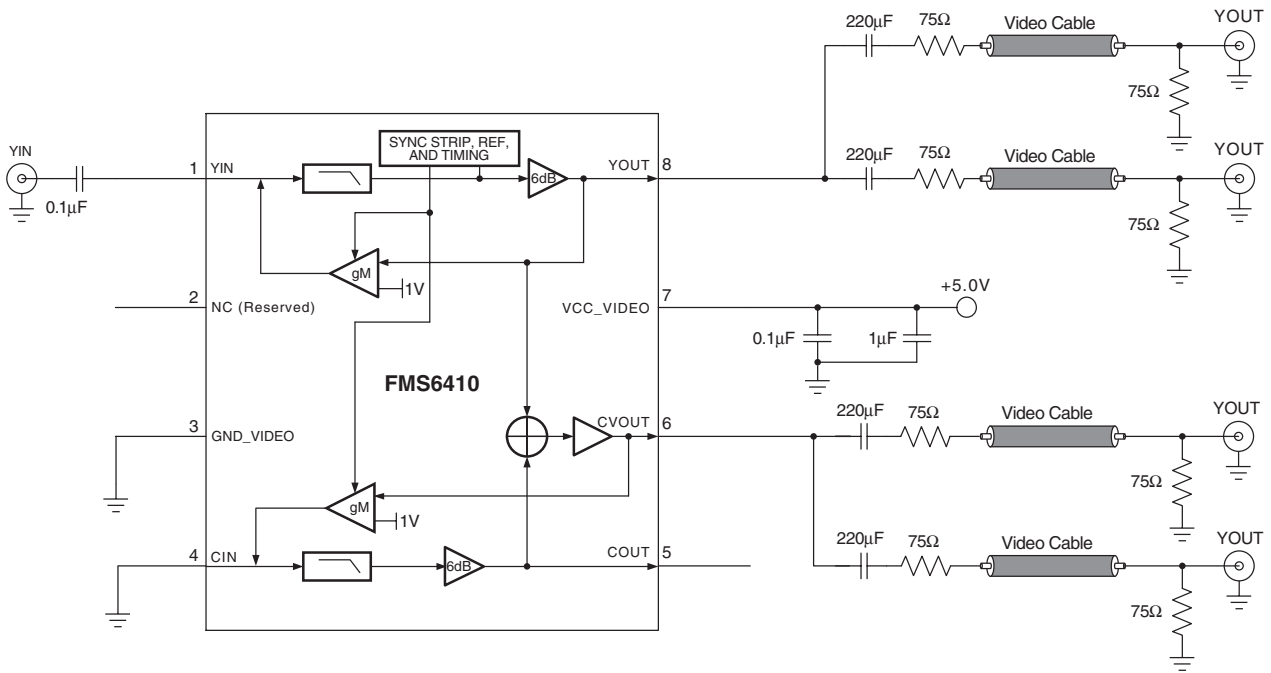
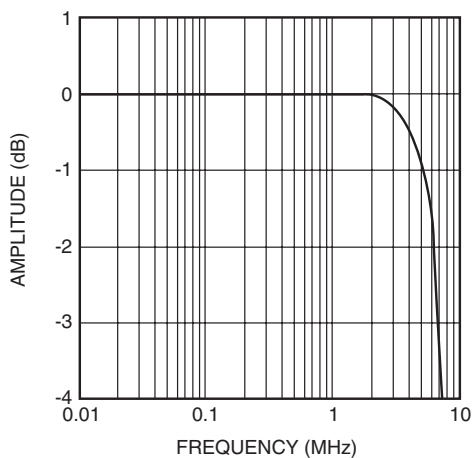
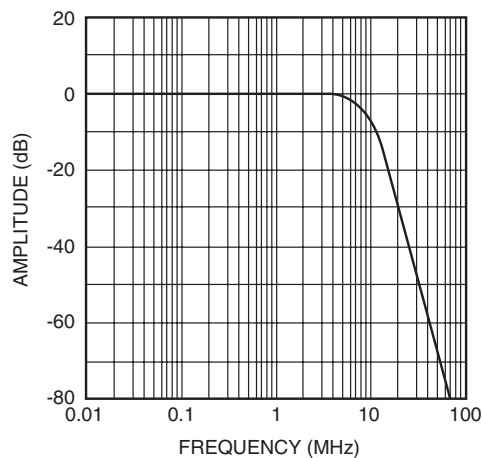


Figure 2. One Input to Four Output Distribution Amplifier Configuration

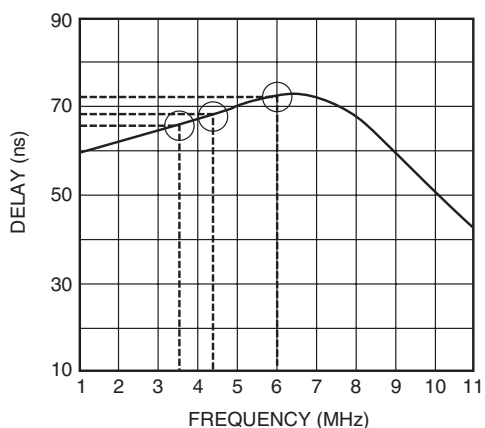
### Typical Performance Graphs



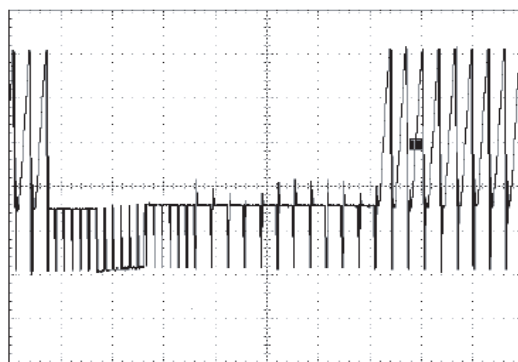
**Figure 3. Passband Flatness for Y, C, and CV outputs (Normalized). Passband is ripple-free.**



**Figure 4. Passband/Stopband Rejection Ratios for Y, C, and CV outputs. (Normalized)**



**Figure 5.  $t_{PD}$  Propagation Delay for Y, C, and CV Outputs**



**Figure 6. DC Restore Performance of Luma Output. Luma ramp test pattern is shown to have minimal tilt during vertical sync.**

## Absolute Maximum Ratings (beyond which the device may be damaged)

| Parameter                            | Min              | Max     | Units |
|--------------------------------------|------------------|---------|-------|
| DC Supply Voltage                    | -0.3             | +7.0    | V     |
| Analog I/O                           | GND-0.3          | VCC+0.3 | V     |
| Output Current (Continuous)          | CV Channel       | 60      | mA    |
|                                      | Y and C Channels | 30      | mA    |
| Junction Temperature                 |                  | 150     | °C    |
| Storage Temperature Range            | -65              | +150    | °C    |
| Lead Temperature (Soldering, 10s)    |                  | 260     | °C    |
| Thermal Resistance ( $\Theta_{JA}$ ) |                  | 115     | °C/W  |

**Note:** Functional operation under any of these conditions is NOT implied. Performance and reliability are guaranteed only if Operating Conditions are not exceeded.

## Operating Conditions

| Parameter                                    | Min  | Typ | Max  | Units |
|--|------|-----|------|-------|
| Temperature Range                            | 0    |     | 70   | °C    |
| VCC_VIDEO Range                              | 4.75 | 5.0 | 5.25 | V     |
| I <sub>CC</sub> (+5 VDC), AC Coupled Outputs |      | 60  | 85   | mA    |

## Electrical Characteristics 1V<sub>p-p</sub> input signal at room temperature

| Video Characteristics - Unless otherwise noted, typical output loading on video output is 150Ω. |  |   |      |     |      |                  |
|---|--|---|------|-----|------|------------------|
| Symbol  | Parameter  | Condition<br>VCC_VIDEO=+5.0V+/-5%   | Min  | Typ | Max  | Units            |
| AV <sub>YC</sub>  | Low Frequency Gain (Y <sub>OUT</sub> , C <sub>OUT</sub> )                                  | at 400kHz   | 5.75 | 6.0 | 6.25 | dB               |
| AV <sub>CV</sub>  | Low Frequency Gain (C <sub>VOUT</sub> )  | at 400kHz   | 5.55 | 5.9 | 6.25 | dB               |
| Y <sub>SYNC</sub>   | Y <sub>OUT</sub> Output Level (During Sync)  | Sync Present on Y <sub>IN</sub>   | 0.75 | 1.0 | 1.25 | V                |
| C <sub>SYNC</sub>   | C <sub>OUT</sub> Output Level (During Sync)  | Sync Present on Y <sub>IN</sub>   | 1.6  | 2.0 | 2.4  | V                |
| C <sub>VSYNC</sub>  | C <sub>VOUT</sub> Output Level (During Sync)   | Sync Present on Y <sub>IN</sub>   | 0.75 | 1.0 | 1.25 | V                |
| t <sub>CLAMP</sub>  | Clamp Response Time (Y Channel)  | Settled to within 10mV, 0.1μF cap on Y <sub>IN</sub> and C <sub>IN</sub>    |      | 5   | 9    | ms               |
| f <sub>1dB</sub>  | -1.0dB Bandwidth (Flatness) (Y <sub>OUT</sub> , C <sub>OUT</sub> , and C <sub>VOUT</sub> ) | No Peaking Cap (Note 1)   | 4.0  | 4.5 |      | MHz              |
| f <sub>C</sub>  | -3dB Bandwidth (Flatness) (Y <sub>OUT</sub> , C <sub>OUT</sub> , and C <sub>VOUT</sub> )   |   | 6.7  | 7.1 |      | MHz              |
| f <sub>SB</sub>   | Stopband Rejection (Y <sub>OUT</sub> , C <sub>OUT</sub> , and C <sub>VOUT</sub> )          | f <sub>IN</sub> = 27MHz   | -37  | -42 |      | dB               |
| V <sub>i</sub>  | Input Signal Dynamic Range   | AC Coupled (All Channels)   | 1.3  | 1.4 |      | V <sub>P-P</sub> |
| I <sub>SC</sub>   | Output Short Circuit Current (Note 2)  | Y <sub>OUT</sub> , C <sub>OUT</sub> , C <sub>VOUT</sub> to GND              |      | 40  | 80   | mA               |
| C <sub>L</sub>  | Output Shunt Capacitance   | All Channels  |      | 35  |      | pF               |
| d <sub>G</sub>  | Differential Gain (Note 3)   | Y <sub>OUT</sub> , C <sub>OUT</sub> , and C <sub>VOUT</sub>                 |      | 0.4 | 1    | %                |
| d <sub>P</sub>  | Differential Phase (Note 3)  | Y <sub>OUT</sub> , C <sub>OUT</sub> , and C <sub>VOUT</sub>                 |      | 0.4 | 1    | °                |
| THD   | Output Distortion (All Channels)(Note 3)   | Y <sub>OUT</sub> / C <sub>OUT</sub> = 1.8V <sub>P-P</sub> at 3.58 / 4.43MHz |      | 0.1 | 0.5  | %                |

**Electrical Characteristics** 1Vp-p input signal at room temperature (continued)

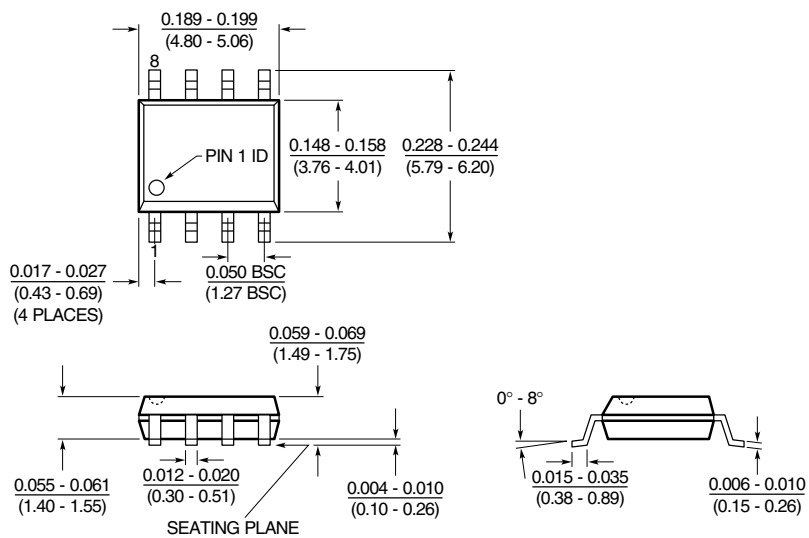
| <b>Video Characteristics</b> - Unless otherwise noted, typical output loading on video output is 150Ω. |   |   |     |     |     |       |
|--|---|---|-----|-----|-----|-------|
| Symbol   | Parameter   | Condition<br>VCC_VIDEO=+5.0V+/-5%   | Min | Typ | Max | Units |
| XTALK  | Crosstalk (Note 3)  | From C <sub>IN</sub> of 0.5V <sub>P-P</sub> at 3.58MHz to Y <sub>OUT</sub>        | -45 | -55 |     | dB    |
|  |   | From Y <sub>IN</sub> Input of 0.4V <sub>P-P</sub> at 3.58MHz, to C <sub>OUT</sub> | -50 | -58 |     | dB    |
| PSRR   | PSRR (All Channels) (Note 3)                                | 0.5V <sub>P-P</sub> (100kHz) at V <sub>CC</sub>                                   | -30 | -40 |     | dB    |
| SNR  | Y, C Channel (Note 3)                                       | NTC-7 weighting 4.2 MHz lowpass   | -65 | -75 |     | dB    |
|  | CV Channel (Note 3)   | NTC-7 weighting 4.2 MHz lowpass   | -60 | -70 |     | dB    |
| t <sub>PD</sub>  | Propagation Delay (Y, C, CV) (Note 3)                       | 100kHz  | 30  | 70  | 110 | ns    |
| Δt <sub>pd</sub>   | Group Delay Deviation from Flatness (Y, C, and CV) (Note 3) | to 3.58MHz (NTSC)   |     | 9   |     | ns    |
|  |   | to 4.43MHz (PAL)  |     | 7   |     | ns    |
| t <sub>SKEW</sub>  | Skew between Y <sub>OUT</sub> and C <sub>OUT</sub> (Note 3) | at 1MHz   |     | 0   |     | ns    |
| T <sub>CLDCV</sub>   | Chroma-Luma Delay C <sub>VOUT</sub>                         | f = 3.58MHz (referenced to Y <sub>IN</sub> at 400kHz)                             | -35 | 0   | 35  | ns    |
| T <sub>CLGCV</sub>   | Chroma-Luma Gain C <sub>VOUT</sub>                          | f = 3.58MHz (referenced to Y <sub>IN</sub> at 400kHz)                             | 92  | 95  | 104 | %     |

**Notes:**

1. Peaking capacitor of 330pF increases output at 4.2MHz nominally by 0.7dB
2. Sustained short circuit protection limited to 10 seconds
3. Guaranteed by Characterization

# Mechanical Dimensions Inches (millimeters)

Package: S08  
8-Pin SOIC





## Ordering Information

| Part Number | Temperature Range | Package          |
|-------------|-------------------|------------------|
| FMS6410CS   | 0° to 70°         | 8 Pin SOIC (S08) |
| FMS6410CSX  | 0° to 70°         | Tape and Reel    |

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